

XII. *Observations on Entozoa, with notices of several new species, including an account of two experiments in regard to the breeding of Tænia serrata and T. cucumerina.*

By T. SPENCER COBBOLD, M.D., F.L.S.

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IN the month of February 1856, I commenced some experiments with the view of confirming the statements of continental helminthologists in regard to the development and habits of the cestoid Entozoa. Unforeseen circumstances prevented my carrying out these investigations to any great extent; nevertheless, as I have, during my past connexion with the Anatomical Museum of the University of Edinburgh, collected and examined numerous forms of Entozoa, I desire to lay before the Society the result of these casual searchings, at the same time offering an apology for the necessarily incomplete and fragmentary character of my remarks.

Excluding Man, the number of vertebrate species examined by me, with especial reference to the presence or absence of Entozoa, amounts to seventy, in forty-five of which worms were detected. This proportion, however, must not be regarded as a fair criterion of the frequency with which these higher orders of animals are infested; for although a great number of individuals—from twenty to forty—of the common species were examined, only one or sometimes two of the species more difficult to procure came under notice. In a statistical point of view, certain particulars in regard to the age of the animal, the time that had elapsed after death before it was examined, and other conditions materially lessening the chances of the detection of Entozoa, would have to be taken into consideration. The forty-five species found to contain worms may be arranged as follows:—

Common Stickleback, *Gasterosteus aculeatus*.

Fifteen-spined Stickleback, *G. spinachia*.

Miunow, *Leuciscus phoxinus*.

Rockling, *Motella quinquecirrata*.

Viviparous Blenny, *Zoarcus viviparus*.

Smooth Blenny, *Blennius pholis*.

Lucky Proach, *Cottus bubalis*.

Haddock, *Morrhua æglefinus*.

Coal-fish, *Merlangus carbonarius*.

Cod, *Morrhua vulgaris*.

Ling, *Lota molva*.

Holibut, *Hippoglossus vulgaris*.

Skate, *Raia batis*.

Pipe-fish, *Syngnathus acus*.

Angler, *Lophius piscatorius*.

Sun-fish, *Orthogoriscus mola*.

Sturgeon, *Acipenser sturio*.

Toad, *Bufo vulgaris*.

Frog, *Rana temporaria*.

Lesser Newt, *Lissotriton punctatus*.

Serpent, *Bothrops* ——— ?

Kite, *Falco milvus*.

Kestrel, *F. tinnunculus*.

Peregrine, *F. peregrinus*.

Sparrow-hawk, *Accipiter nisus*.

Honey Buzzard, *Pernis apivorus*.

Long-eared Owl, *Strix otus*.

Redshank, *Totanus calidris*.

Curlew, *Numenius arcuata*.

Grey Gull, *Larus glaucus*.

Kittiwake, *L. tridactylus*.

Guillemot, *Uria troile*.

Auk, <i>Alca torda</i> .	Rabbit, <i>Lepus cuniculus</i> .
Red-throated Diver, <i>Colymbus septentrionalis</i> .	Dog, <i>Canis familiaris</i> .
Golden Pheasant, <i>Phasianus pictus</i> .	Lion, <i>Felis leo</i> .
Capercailzie, <i>Tetrao urogallus</i> .	Ox, <i>Bos taurus</i> .
	Sheep, <i>Ovis aries</i> .
Mouse, <i>Mus musculus</i> .	Giraffe, <i>Camelopardalis giraffa</i> .
Cat, <i>Felis catus</i> .	Porpoise, <i>Delphinus phocæna</i> .

In this list, notwithstanding the unfavourable circumstances above alluded to, I have found no less than sixty forms of Entozoa infesting forty-five vertebrate species; and there cannot be the slightest doubt, as subsequent observations will show, that this figure affords but a very low estimate of the liability of invasion to which these creatures are exposed. It is also worthy of remark, that out of those species in which Entozoa were not found, only one belonged to the fish tribe; whereas a very careful examination failed to detect any worms in several kinds of birds and mammals. Among those species not harbouring Entozoa, but in which their presence might have been anticipated, were the following:—Wild Duck, Swan, Woodpecker, Starling, Pheasant, Tawny Owl, large Water Newt, Water Rat, Squirrel, Stoat, Otter, Badger, Fox, and common Brown Bear.

Six or eight species of Entozoa have been described as inhabiting *Gasterosteus aculeatus*, but I have only met with three; namely the *Tenia filicollis* (Pl. XXXI. fig. 1); an imperfect specimen of cestoid worm corresponding in some respects with the *Schistocephalus dimorphus* of Creplin, and a small trematode presumed to be the *Monostoma caryophyllum* in a very young state (figs. 2, 3). The head of *T. filicollis*, according to the descriptions of Dujardin and others, is simple, globular, unarmed with the usual proboscisiform retractile tubercle, and unprovided with lateral suckers. In those which have come under my notice, a very distinct proboscis was to be seen while the specimens remained fresh, but there was no indication of hooks; these may have fallen off. Four well-developed suckers surrounded the head, and the water-vascular canals were unusually conspicuous throughout the entire segmental series. In an adult individual, these tubes, four in number, terminated superiorly so close to the cup-shaped *bothria*, that it was difficult to divest oneself of the notion that they communicated with the latter.

After a fruitless search for Entozoa in many specimens of *Gasterosteus spinachia*, one example at last yielded an extremely minute trematode (figs. 4, 5), enclosed in a cyst of cellular tissue and attached to the subperitoneal surface of one of the ovaries. While under microscopic examination it was accidentally swept off the slide, but an outline of its structure has been preserved. A feature in this specimen consists in the presence of an unusually large ventral appendage, the free extremity of which is bifid and each division apparently perforated. The hermaphroditic signification of this organ is evident; but the circumstance of the ends of the male and female reproductive tubes being thus greatly extended, may in some measure be regarded as accidental. Traces of a bifurcate stomach were plainly discernible, the canals being slightly sinuous. As I am unable to refer this worm to any known species, I recognize it provisionally under the signification of *Monostoma dubium*.

In *Motella quinquecirrata*—the *Gadus mustela* of Linnæus—Rudolphi mentions the

occurrence of a cestoid entozoon. This species of *Bothriocephalus* I have not seen; but in a specimen of the above-named fish its place was supplied, as it were, by two other worms—the *Distoma fulvum* (figs. 6, 7, 8), hitherto observed in the Ling and *Gadus mediterraneus*, and the common *Filaria piscium*, which is especially abundant in the Cod-tribe. So far as I am aware, the *Distoma fulvum* has not yet been figured under that name, but after a careful investigation I am satisfied that it is identical with the *D. simplex* of Rudolphi and *Fasciola Bramæ* of Müller\*. Dujardin, after giving the specific characters of *D. simplex*, appends an account of two unnamed trematodes which he found in a specimen of *Gadus quinquercirratu*s from the coast of Brittany; these also appear to me to be one and the same species, and I think he would have been justified in considering them as merely altered forms of *D. simplex* or *D. fulvum*. Dujardin moreover makes *D. simplex* synonymous with the *Fasciola Æglefini* of Müller and the *D. Wachniæ*, first described by Tilesius†. After consulting the figures and descriptions of these authors, I consider *D. Wachniæ* to be the original representative both of *D. simplex* and *D. fulvum*, but I believe *F. Æglefini* may be properly regarded as a distinct species. The living specimens of *D. fulvum* examined by me alternately elongated and contracted themselves very vigorously, thus varying the length of the body between the twelfth and fortieth part of an inch. In this way the neck sometimes became extremely attenuated, contrasting strongly with the large and prominent ventral sucker. Under a half-inch lens, the largest specimen, as now preserved, exhibits the intromittent organ everted and the convoluted uterine tube crowded with ova.

The only entozoon I have observed in the viviparous Blenny is a single specimen of *Ascaris aucta*, R. It was coiled in a cyst beneath the peritoneal surface of the liver, the gland being otherwise diseased. In an example of *Blennius pholis*, four specimens of *Echinorhynchus tereticollis*, R., were obtained from the intestine, in different stages of development. The largest exhibited a bulging of the cuticle near the middle of the body, probably the result of injury.

*Cottus bubalis*.—Several were examined and only one found infested—that by a single tape-worm, which occupied the intestine immediately below the pancreatic cæca. This entozoon, long known to inhabit *Cottus scorpius*, and by Müller termed *Tenia Scorpii*, has been more fully described by Leuckart, Eschricht, and Van Beneden, under the better title of *Bothriocephalus punctatus*. The extreme transparency of this worm, when alive, produced, during its active movements, very puzzling appearances, and had I not previously entertained the persuasion that all tape-worms were destitute of a true digestive tube and buccal cavity, I should have felt entitled to affirm, that this species at least was provided with a continuous alimentary canal. The anterior cephalic segment, while extended, greatly exceeded in length each of the ten or twelve succeeding segments, and when contracted appeared rather broader. Müller's figure gives an idea of considerable disparity in this respect, but in other particulars the specific resemblances were at once recognized. Toward the lower part of the so-called neck, the joints exhibited at the lateral margins indications of division, which became gradually more defined towards the tail.

\* Zoologia Danica, tom. i. p. 33. pl. 30. fig. 6.

† Mém. de l'Acad. des Sciences de St. Pétersb. tom. ii. p. 363. tab. 19. figs. 8-10.

In the Haddock and others of the Cod-family we meet with many kinds of Entozoa and the worms found in one species seem liable to occur in all members of the group. Most of the *Trematoda* infesting fishes are exceedingly minute, and it is absolutely necessary for their identification that specific descriptions should be accompanied with accurate figures. I am led to this remark from the difficulty of making out the identity of a *Distoma* found associated with *Echinorhynchus acus*, R., and *Bothriocephalus rugosus*, R., in the intestine of a Haddock. The trematode in question agrees in some respects with *D. scabrum* and *D. appendiculatum*, especially the latter, but differs in a few essentials; moreover, *D. appendiculatum* is not mentioned as infesting the Gadidæ. Provisionally therefore I propose to regard it as a distinct species, and shall briefly describe it under the title of *D. racion* (ῥαχιαῖον), as follows (figs. 9, 10):—Body of a faint pink colour; length 3 lines; flat, covered with minute spines; obtuse at either extremity; posterior half of the body rather broader than the front; oral sucker large, not quite terminal; ventral sucker comparatively small, near the centre of the body; œsophagus narrow, twisted, bifurcating immediately above the ventral sucker; gastric canals very capacious; genital pore large and conspicuous; internal seminal vesicle, uterine tube, ovary, testes, and contractile vesicle particularly distinct. Some other details in regard to the structure of this trematode will be found indicated in the explanation of the accompanying figures. In regard to *Bothriocephalus rugosus* I have only to observe, that in consequence of the head being found in all instances firmly rooted within one of the pancreatic cæca, it was impossible to ascertain the precise form of the cephalic segment. Dujardin remarks the same peculiarity in specimens obtained by him from *Gadus pollachius* and *G. mertucius*. The single *Echinorhynchus*, obtained from the same Haddock, exhibited when alive an organ lying near the proboscideal sheath—the so-called lemniscus, concerning the use of which we are still ignorant. In common with others, I have observed, in another acanthocephalous species, two of these organs, one on each side of the sheath. They have no connexion with the retractor museles; but the latter, in the example under consideration, could not be recognized through the semi-opaque integument. A Haddock examined by me on the 8th of May, 1854, contained, in addition to two specimens of the above-mentioned *Bothriocephalus*, several small cysts enclosing *Filaria*, and a larger solitary cyst occupied by a *Tetrarhynchus* (figs. 11 to 19 inclusive). These require a passing notice. The minute sacs were imbedded in the submucous tissue of the alimentary canal, and scarcely exceeded half a line in breadth. The single large cyst, situated beneath the peritoneum outside the intestine, measured about a quarter of an inch long, and one-eighth of an inch broad. It was oval, semitransparent throughout, and on division of the peritoneal investment, easily removed. When detached, the fibro-cellular investing capsule or ectocyst offered a pyriform outline, and from its narrow extremity there proceeded a stalk-like prolongation. The ectocyst on being torn open disclosed the tetrarhynchoid *Scolex*, the head and body of which were invaginated, but became readily evolved by gentle pressure applied to the bulky caudal vesicle or endocyst. Amplified forty diameters, the internal structures were well seen, the proboscoidiform tentacula and “sclerous particles” being especially conspicuous. I have here, with due consideration, applied the term “sclerous” to the subcutaneous corpuscles so abundant in the caudal vesicle, in

order to signify my adhesion to the view of Siebold and others as to their earthy nature. Helminthologists express various opinions in regard to their structure and function. All the older writers speak of them as "ova;" whilst other, more recent observers, following Eschricht, ascribe to them a nutritive function. The late Prof. William Smith of Cork apparently adhered to this latter view, for in his interesting paper on "Measled Pork," he designates these corpuscles "assimilating cellules\*," whilst the distinguished Belgian entozoologist, Prof. Van Beneden, attributes to them a still higher organization, calling them cutaneous glands†. The ordinary cellules of the parenchyma were found to be comparatively small, requiring the aid of a quarter-inch lens for their satisfactory definition. The epidermic cells showed in profile very fine markings, indicating a columnar epithelium; and immediately beneath the corium there were outlines of anastomosing tubes, which appeared to represent a water-vascular system. The armature of the retractile proboscides is rather complicated; each proboscis being made up of numerous segments, and every joint supporting quadruple rows of four hooks, sixteen in all; the superior set being disproportionately large.

Having thus cursorily alluded to five different forms of Entozoa infesting the Haddock, I pass to the consideration of worms found in the Coal-fish, common Cod, and Ling.

*Merlangus carbonarius. Morrhua vulgaris.*—Numerous examples of *Ascaris clavata* (R.) occupied the intestinal canal of one individual. No other species of Entozoa were detected in the limited number of specimens examined. In a Cod examined on the 15th of March, 1855, two specimens of *Bothriocephalus rugosus* had severally attained a length of nearly fifteen inches, and their anterior segments, for an inch or more downwards, were so firmly impacted within the pancreatic cæca, that it was found impossible to dislodge them without injuring the filamentary head and neck. As if to make the anchorage doubly secure, the cartilaginoid thickening of the invaded pancreatic cæcum had degenerated into a calcareous and contracted cylinder, twisted upon itself in various ways.

*Lota molva.*—On the 31st of March, 1855, two kinds of nematoid worms, differing in relative size, were obtained from the intestinal tube. The smaller species, about half an inch in length, may be referred to an entozoon described by authors under a variety of names. It is the *Cucullanus marinus* of Zeder and Müller, the *C. foveolatus* of Rudolphi, and the *Dachnitis globosa* of Dujardin (figs. 20–23). The vaginal orifice of the female is situated near the middle of the body, being protected by two prominent folds of integument. The spicules of the male, two in number, are sabre-shaped, and there is a spacious sucker-like depression in front of the anal opening. The larger round-worms

\* Microscopical Journal, vol. v., description of pl. 2.

† Recherches sur les Vers cestoides, p. 23:—"ils consistent dans de courts cæcums légèrement ramifiés, et sécrètent un mucus destiné à lubrifier la surface du corps."

Since the above was written, a paper by M. E. Claparède has appeared in Siebold and Kölliker's Zeitsch. f. Wissensch. Zoologie, vol. ix. p. 99, on the subject of the calcareous corpuscles of the Trematoda, in which it is shown that these bodies are lodged in the dilated extremities of branches of the so-termed "water-vascular" or excretory system of vessels. This interesting fact seems to have been demonstrated to the satisfaction of Joh. Müller, Virchow, Lachmann, and others, and to have been previously known to, though not published by, Dr. G. Wagener. And with respect to it, it may be remarked that so far back as 1830, Laurer pointed out that the ultimate branches of this system of vessels terminated in minute vesicular dilatations in *Anphistomum conicum*, although a similar condition could not be detected by Nordmann in *Diplostomum volvens*.

above mentioned cannot, so far as I know, be satisfactorily referred to any species of *Ascaris* or other nematode at present described; and although unwilling to multiply species in a group of Entozoa already extended numerically far beyond the proper limits, there is in the present instance no alternative. *Ascaris acanthocaudata* (mihi) may be identified as follows:—Body 10 to 15 lines long, half a line broad; diameter slightly increased toward the head, suddenly narrowed at the tail; mouth trilobular; caudal extremity armed with several minute spines (figs. 24–26). A preserved specimen in my collection exhibits the transverse and longitudinal muscular layers with unusual clearness; but the most interesting structure, which can be seen with a half-inch lens, and its minute tissues with a quarter-inch objective, consists of a broad double band of partially disintegrated cellules, extending from head to tail on the under side of the body. The centre of this band is occupied by a well-defined canal apparently containing a delicate white thread. It does not give off any branches, but terminates superiorly in an abrupt manner immediately below the trilobular mouth. From this point there is a faint appearance of radiating lines towards the margin of the lobes, but I cannot positively say that they are nervous filaments. Notwithstanding this doubt, I am confident that the long-entertained opinions of Otto and Siebold, in regard to the existence of a nervous cord in the Nematodea, are correct.

*Hippoglossus vulgaris*.—A specimen dissected on the 4th of May, 1854, yielded two forms of thread-worm—*Filaria piscium* and *Ascaris collaris*\*. Examples of the former were coiled within the mesenteric folds, while the latter were chiefly enclosed in cysts, in and upon the mucous membrane of the intestine. A fully-developed *Ascaris collaris* (Pl. XXXII. fig. 27) presented the following characters—here given on account of certain difficulties in the way of identification:—Body an inch in length, comparatively thick; head obtuse, trilobular valves of the mouth very small; œsophagus narrow, communicating with a broad intestine, bounded on either side by two slender cæcal appendages of unequal length and vesicular at the free ends†; caudal extremity rounded, rather narrower than the head; anal orifice in front, not far distant. In addition to these nematodes, the intestine contained numerous specimens of *Scolex polymorphus*, and there was also a minute trematode enclosed in a capsule beneath the peritoneal membrane. The anatomy of various Scolex-forms has been beautifully illustrated by Prof. Van Beneden and Wagener‡; nevertheless I remark upon one or two particulars in passing. In this Scolex (figs. 28, 29) the simple structure of the sclerous particles formerly alluded to is most satisfactorily seen, and it is difficult to understand why such discrepancy of opinion should prevail in regard to their nature. Siebold long ago recognized their dermo-skeletal character. The four presumed water-vascular canals take their origin by two single trunks, one on each side of the lower part of the probosciform sucker; there is no appearance of intercommunication, however, between them and the cavity of the cup. The encysted trematode corresponds in many respects with the *Fasciola Platessæ* of Müller, answering more closely, however, to the *Distoma atomon* found by Rudolphi in *Pleuronectes flesus*

\* According to Miescher, Steenstrup, Wagener, &c., the *Filariæ* are only young Nematodea.

† In *Cheiracanthus robustus*, Diesing remarks the presence of four similar lemnisciform bodies.

‡ Die Entwicklung der Cestoden, &c. 1854.

(figs. 30–32). It is not unlikely that these are one and the same species, seeing that the principal difference, according to Dujardin, consists in the colour of the body and in the relative size of the ventral sucker. A living *Distoma* varies much in form during contraction, and the same worm will present appearances when preserved very unlike those seen when it was fresh. I have found this to be the case especially in the entozoon under consideration, the ventral sucker presenting, during life, a most unusual breadth. The oral sucker was comparatively small; the simple gastric cæca, uterine tubes and contractile vesicle being severally large and conspicuous.

*Raia batis*. *Syngnathus acus*.—Of Entozoa infesting the former, I have only to notice the extreme abundance of *Bothriocephalus coronatus* (R.) occupying the chambers of the spiral intestine. Under an amplification of 400 diameters, the advanced ova exhibit a well-developed Scölex, provided with rudimentary hooklets and sclerous particles. In the common Pipe-fish I have found several specimens of *Filaria piscium*.

*Lophius piscatorius*.—The voracious habits of the Angler guarantee the presence of a variety of worms, and, with the exception of *Orthogoriscus*, no fish is perhaps more copiously infested. A specimen, dissected May 12, 1854, yielded three species of Entozoa, namely *Ascaris rigida*, *Scolex polymorphus*, and *Distoma gracilescens*. Most of the nematode individuals were imbedded in folds of the peritoneum and mesentery, the other kinds occupying the intestinal canal. Published descriptions of *Distoma gracilescens* (figs. 33–37 inclusive) being few and imperfect, I offer the following notice of its more obvious characters:—Body of a pale brown colour, semitransparent, one-sixth of an inch long, flat, linear, beset all over with minute tubercular spines, those about the head being more eogently developed; anterior half somewhat narrower than the posterior; oral sucker oval, not quite terminal; ventral sucker circular; sheath of the penis large, and placed immediately below the ventral cup; uterine tube broad and tortuous, occupying the inferior half of the body; vitelline organs consisting of two elongated, botryoidal masses, commencing a little below the oral sucker and passing down on either side of the neck; testes bulky, transparent, placed toward the lower and back part; in front of these, two smaller vesicular bodies, corresponding to the ovary and seminal vesicle; contractile vesicle very large, with thick muscular walls.

*Orthogoriscus mola*.—I have dissected, in its entirety, but one specimen of this remarkable fish. It was a very young individual, and was captured off Anstruther, on the coast of Fife, September 6, 1856\*. There were no Entozoa in the intestinal canal, but the liver and retractor muscles of the anal fin contained several examples of the *Gymnorhynchus reptans* of Rudolphi (figs. 38–46 inclusive). Professor Goodsir has given an accurate description of this cestode in the Edinburgh New Philosophical Journal for 1841, under the title of *G. horridus*, regarding it as a new species. If I may be allowed to differ, I do not think the circumstance of Bremser's having omitted to notice the two lowermost rows of exaggerated hooks on the proboscis, or his non-observance of the jointed condition of the body, as sufficient evidence that these characters were not present in his *G. reptans*.

\* Its dimensions were as follows:—Length from head to tail, 18 inches; between tips of dorsal and anal fins, 26 inches; greatest depth of the body, 12 inches; length of pectoral fins, 2 inches and a half; width of the gill-aperture, 1 inch. Two or three other individuals were taken a few weeks previously in the Firth of Forth.

It requires considerable enlargement and a good lens to render the comparatively large size of the hooks obvious, and the articulations of the body are but very faintly indicated toward the anterior part of the animal. Notwithstanding the fish in question had been dead several days and cast aside as refuse by the salesman of whom it was purchased, the Entozoa coiled within the muscles were alive, and on being removed to a tumbler of seawater, they continued to live until the third day following, when they were placed in spirit. During the active movement of contraction and elongation, the proboscidiform tentacula were freely protruded and withdrawn. It was difficult to ascertain the exact number of hooklets upon these processes. I think every circular row carries sixteen, and there are about one hundred of these rings of hooklets on each proboscis; if this estimate be correct, the total number of hooklets is 6400. The form of the proboscis is clavate, and its free extremity more or less rounded; in relative size the hooklets are tolerably uniform, those towards the tip being rather larger; the two lowermost rows of the series are very highly developed.

*Acipenser sturio*.—On the 25th of April, 1855, I obtained a great many examples of *Dachnitis sphaerocephala* of Dujardin (Pl. XXXIII. fig. 51) and *Distoma hispidum* (Abildgaard) from the spiral intestine. Contrary to the statements of Creplin, I find the hooks surrounding the head of the latter remarkably conspicuous and disposed in two rows, fourteen in each. I think it would be preferable to place this species in the subgenus *Echinostoma*. (Pl. XXXII. figs. 47, 48; Pl. XXXIII. figs. 49, 50.) Dujardin retained it among the true Distomata with hesitation. The integumentary spines in front are prominent, and directed outwards with a slight inclination backwards; those below the ventral sucker become gradually smaller, and finally degenerate into mere tubercles at the posterior extremity.

*Rana temporaria*.—From different individuals I have obtained *Filaria rubella* (?), *Ascaris nigro-venosa*, *A. acuminata*, *Oxyuris ornata*, *Distoma cylindraceum*, *D. clavigerum* (figs. 52, 53), and *Polystoma integerrimum*, the latter being fully half an inch in length\*.

*Bufo vulgaris*.—With reference to parasites, I have only examined one or two examples of the common Toad, and in the intestine of an individual dissected on the 20th of April, 1855, found a single specimen of *Ascaris acuminata* associated with numerous small flukes. These trematodes are fully as large as the *Distoma cygnoides*, frequently infesting the urinary bladder of the Frog; nevertheless they may probably be referred to a smaller species—the *D. clavigerum* of Rudolphi, their length varying from one to two lines and a half. The vitelline ducts, the uterine canal with its crowded ova, and the long intromittent organ, are readily distinguishable in preserved specimens.

*Lissotriton punctatus*.—I here wish to call attention to a striking illustration of the predilection for a particular species which certain Entozoa exhibit in selecting their habitation. A careful dissection of some thirty or forty Water-newts—consisting of our two most common species, the large black and the lesser speckled Salamanders in nearly equal proportions—has shown, that while in almost every instance worms were present

\* The anatomy and development of these and other forms of Frog's flukes have recently been illustrated by Dr. H. A. Pagenstecher in his attractive monograph, entitled "Trematodenlarven und Trematoden," Heidelberg, 1857. Also in Dr. Wagener's "Entwicklungsgeschichte von *Distoma cygnoides*."



in *Lissostriton punctatus*, not a single entozoon of any kind could be obtained from *Triton cristatus*; a fact rendered more significant inasmuch as the specimens were all obtained from the same locality, namely from ponds at the summit of the Braid Hills near Edinburgh. In the stomach of one of the large species there was a small trematode-like body, but on microscopic examination it proved to be a young horse-leech. From specimens of the lesser Newt, procured at intervals during the months of April, May and June, 1855, there were obtained in the first place numerous examples of *Ascaris acuminata*, the presence of which was by no means invariable; secondly, an abundance of *Echinorhynchus anthuris*; thirdly, multitudes of *Opalina intestinalis*, a ciliated infusorial animalcule believed by Agassiz to be in reality only a larval planarian; and fourthly, a considerable number of *Trichodinæ*. The first three groups were found in the stomach and duodenal portion of the intestinal canal; the fourth occupying the cloaca and ducts in its immediate neighbourhood. The only remark I have to offer respecting *Ascaris acuminata* has reference to its size, which is variously estimated by different authors; my specimens average about 8 lines in length, which accords with Mr. Bellingham's statement in his Catalogue of Irish Entozoa. This leads me further to observe, concerning the definition of species, that much unnecessary stress is laid upon the relative size of individuals, bulk alone, it would appear, being frequently regarded as a criterion of specific distinction. In very many instances at any rate it cannot be denied that this is the case. I believe the error is so prevalent in the older lists, that for every new species now added, two old ones might with propriety be expunged. In the present communication, it is not my intention to show how the truth of this assertion may be sustained by an appeal to facts; nevertheless, if it were desired, sufficient illustration might be afforded from the materials in hand. The second group, represented by *Echinorhynchus anthuris* (figs. 54–62 inclusive), deserves attention, forming as that species does, on account of its small size and extreme transparency, an excellent subject for microscopic investigation; but a minute description is not needed, in consequence of the admirable manner in which it was originally described by its discoverer, M. Dujardin. General details being given in the description of the figures, attention in this place is only invited to a brief notice of the peculiar ova. These characteristic bodies in their early state are perfectly round, appearing simply as nucleated cellules in the interior of the so-called ovaries, which are also spherical, and float loose in the cavity of the body; the nucleus may be taken to represent the germinal vesicle, but it cannot be recognized in the fully developed ovum. In this latter condition each ovum encloses a perfectly transparent cell, lobed at both ends after the fashion of *Trichina*, and an irregular but very distinctly granular yelk-like mass; these are placed side by side; and from the granular body proceeds at either end a coiled thread or chalaza advancing to the extremity of the external envelope and becoming blended with it; the wall of the transparent cell exhibits in profile very delicate undulations. In regard to the infusorial *Trichodinæ*, which may yet turn out to be larval forms of some higher group, I have only to observe that some were in the encysted condition.

*Bothrops*.—For an opportunity of dissecting a species of this genus I am indebted to Mr. Edwards, Demonstrator of Anatomy in the University of Edinburgh. Several ex-

amples of *Pentastoma proboscideum* occupied the mesenteric folds, but with reference to their structure I am unable to add any new or otherwise interesting facts.

Passing to the consideration of Entozoa in birds and mammals, my remarks under the former head will be very short, as they are designed to indicate little more than a record of worms found in particular species.

*Falco milvus*.—In the duodenum of a Kite opened on the 16th April, 1855, there were present five or six specimens of *Ascaris depressa*, several examples of *Trichosoma Falconum*, and multitudes of *Hemistomum spathula* (Diesing). The latter—better known as the *Amphistoma macrocephalum* of Rudolphi—presented a bright grass-green colour, owing to the quantity of bile in the intestine. Outside the gut there was a minute botryoidal fatty mass, consisting of four unequal lobules united together and attached by two filamentary stalks; each of these lobes contained an encysted nematode.

*Falco tinnunculus*; *F. peregrinus*; *Accipiter nisus*; *Pernis apivorus*; *Strix otus*.—Specimens of *Ascaris depressa* were obtained from a Kestrel on the 21st of January, 1856, and being very numerous they completely choked that part of the intestine in which they were lodged; a solitary individual was also procured from the duodenum of a Honey Buzzard on the 30th of May of the previous year. From the cellular aponeurosis at the back of the abdominal cavity of a Peregrine, I also obtained in April of the same year a single specimen of *Filaria attenuata*, measuring nearly  $10\frac{1}{2}$  inches; and from the stomach of a Sparrow Hawk dissected in January 1856, an example of *Spiroptera leptoptera*. This last entozoon I have also found associated with *Hemistomum spathula* in the small intestine of the Long-eared Owl in the month of January.

*Totanus calidris*; *Numenius arcuata*.—I have taken *Tenia variabilis* from the small intestine of the former of these allied species in January, and also *T. sphaerophora* (figs. 63–67 inclusive) from the Curlew at the same period in great abundance, the latter entozoon being situated midway between the gizzard and cloaca. As this cestode is only imperfectly known, some additional facts in regard to it may prove acceptable. The head is correctly described by Diesing as obcordate, but no mention is made of the armature of hooks surrounding the *rostellum*; this is not to be wondered at, considering the facility with which they drop off after death, or during life, on even the most gentle handling. One cannot judge how many it carries from the number found in the *proscoteles*, where there appear to be six hooks arranged as usual in three pairs on the proboscis; and in no case have I seen the adult cestode with its full complement. The anterior segments are extremely narrow, but well defined immediately below the head, the sucker-bearing and proboscideal divisions appearing to represent very distinctly two rings of the segmental series, or in other words, the first two modified individuals of the colony, if we can suppose with Van Beneden each *proglottis* to represent an independent animal. The middle and succeeding segments become gradually broader and deeper toward the caudal extremity, the lateral margins showing a bilobular outline; the intromittent organs are placed consecutively on one side only, their bulk being comparatively large; and the external wall of the sheaths is closely beset with minute spines directed backwards when the organs are protruded. The segments near the tail seemed ready to burst from the volume of the contained ova, most of which latter, when withdrawn and

examined separately, displayed internally that advanced condition of the embryo termed *proscölex* by Van Beneden.

*Larus glaucus*; *L. tridactylus*; *Uria troile*; *Alca torda*; *Colymbus septentrionalis*.—In the months of December and January, 1854–55, I obtained from the common Grey Gull abundance of *Tetrahelminthium cylindraceum* (the *Bothriocephalus macrocephalus* of Dujardin) and *Echinostomum spinulosum*. The latter (figs. 68–72) is usually described as a *Distoma*, but ought certainly to be generically separated. I find the disc surrounding the head capable of being elevated so as to form a kind of hood; and the hooks being connected together by an extension of the integument, the coronet resembles the fin of a fish. The vitelline organs have a peculiar zigzag conformation, the cæca alternating in parallel rows. In the small intestine of the Kittiwake I have also constantly found *Tetrahelminthium cylindraceum*, and from the same situation in the Red-throated Diver quantities of *T. macrocephalum*, which Diesing—correctly, I think—regards as distinct from the former. From the œsophagus and proventriculus of the Auk and common Guillemot I have procured, during spring, numerous examples of *Ascaris spiculigera*; one dissection in the case of *Uria troile* exposing two of these nematodes lodged in the auricle of the heart. The intestines of another specimen of this bird contained several individuals of a cestode, which has been vaguely indicated by Abildgaard under the title of *Tænia Colymbi Troiles*; I have not been able to satisfy myself, however, that this species is distinct from *Tetrahelminthium macrocephalum*.

*Phasianus pictus*; *Tetrao urogallus*.—Both cæca of a Gold Pheasant, dissected on the 7th of January, 1856, were found enlarged to three or four times their natural width, owing to the presence of a multitude of dark-coloured tubercles, about the size of peas, the interior of each of which contained a coiled nematode, the *Ascaris vesicularis* of Frölich. From the intestine of a Capercaillie, examined in the spring of the previous year, were procured numerous specimens of *Trichosoma longicolle*; and also from the subcutaneous areolar tissue overlying the great pectoral muscle, a solitary entozoon resembling *Ligula reptans*.

*Mus musculus*; *Felis catus*.—Fresh experiments are not required to determine the now well-established fact in regard to the *Cysticercus fasciolaris* of the Mouse being the imperfectly developed *Tænia crassicollis* of the Cat; indeed, long before their actual identity was demonstrated, the frequent occurrence of a cestoid condition of the Scolex within the liver suggested an hypothesis which has since proved correct. In my collection there is a specimen of this helminth in the tænioid condition taken from the liver of a White Mouse, which is nearly as long as that figured by Bremser. Such examples are by no means uncommon. In addition to *Ascaris mystax* and *Dochmius tubæformis*, the only other worm I have seen in the domestic Cat is the *Tænia elliptica*, but, like Dujardin, I have been unable to obtain its head.

*Lepus cuniculus*; *Canis familiaris*.—The experimental researches of Von Siebold, Küchenmeister, Leuckart, and other continental helminthologists, have sufficiently established a mutual relation between *Cysticercus pisiformis* and *Tænia serrata*, hereby affording an additional instance of the truth of Steenstrup's law of alternate generation. I am not aware if any entozoologist in this country has attempted to repeat their experi-

ments, and I therefore regret that circumstances have prevented my carrying out more fully an intention of verifying some of those particulars which have recently attracted our notice. Two of a few experiments, however, having been completed and attended with partially satisfactory results, I take this opportunity of placing them on record:—

On the 5th of February, 1856, I administered to a Dog three minute *Cysticerci*, obtained from the fresh livers of two wild Rabbits. These cysts were perfectly round and measured only the twelfth of an inch in diameter, and were evidently not to be referred to the common *C. pisiformis*. A fortnight after (19th) six similar cysts were obtained from the liver of another wild Rabbit and given to the same Dog. Ten days subsequently the canine animal was destroyed by chloroform, when, on laying open the small intestines, six specimens of *Tenia cucumerina* were detected. Three of these individuals were severally about 12 inches in length, the others measuring only 3 inches. Thus far, therefore, but for the circumstance of three of the nine cysts administered being undeveloped or lost, no doubt whatever could be entertained as to the complete success of this experiment. As it is, we have the interesting result of three nearly completely developed tape-worms, the growth and number of which exactly correspond with the circumstances that apparently led to their presence in the viscera of the Dog; and in addition we have three other individuals, only one-fourth of the bulk of the former, which may legitimately be regarded as the partially developed representatives of three of the six *Cysticerci* that were subsequently administered. It would appear, in consequence of the *C. pisiformis* being frequently present in the liver of the Rabbit, as well as in the mesentery, that our minute *Cysticercus* has not hitherto been recognized as distinct; at least, I find no notice of it in foreign works, and shall therefore in future speak of it as *C. cucumerinus*. In order to impart additional value to the above experiment, a young tame Rabbit was next procured, and the three larger *Tænia*s (whose caudal proglottides contained multitudes of imperfectly formed ova) were given to it, the living worms being greedily devoured with portions of a cabbage-leaf. Eleven days after, the Rabbit was destroyed, and the liver found to contain numerous minute cysts corresponding to those of *C. cucumerinus*, the great omentum likewise containing four specimens of *C. pisiformis*. No inference of any value can be deduced from the presence of both kinds of *Cysticerci* in this case, for they are almost always present in tame Rabbits, young or old, whether they have eaten tape-worms or not. On the same day, 11th March, portions of the liver were given to a young Dog, and on the 17th many examples of *C. pisiformis* from the omentum of another tame Rabbit were given to the same animal. Two or three days before the second worm-feeding, this dog had commenced ejecting its ordinary food, and I have no doubt that by far the greater part of the more recently introduced worm-feedings shared the same fate. This throwing up of the stomachal contents was followed by total abstinence; and as the dog appeared weak, it was accordingly destroyed on the 20th, thus allowing only three days for the development of any pisiform *Cysticerci* that might chance to be retained, and but nine days for the small liver-cysts. The result was as follows:—Seven tape-worms were present in the intestine; of these, four were specimens of *Tenia cucumerina*, varying from 3 to 10 inches in length, and the remaining three were examples of *T. serrata*, the segmentation of which was scarcely manifested, the longest individual measuring less than an

inch. On the whole, therefore, it is reasonable to conclude that the latter experiment confirms the statements of Leuckart and others as to *C. pisiformis* being the young of *T. serrata*, whilst both experiments satisfactorily demonstrate the breeding of *T. cucumerina* from a minute Cysticercus, probably hitherto unnoticed (figs. 73-79)\*.

The other species of Entozoa casually observed by me in *Lepus cuniculus* and *Canis familiaris*, are *Fasciola hepatica* and *Oxyuris ambigua* in the former, and *Ascaris marginata* in the latter.

*Felis leo*; *Bos taurus*; *Ovis aries*; *Camelopardalis giraffa*.—From a partial examination of the viscera of two Lions, the only entozoon detected was *Ascaris leptoptera*. I have carefully dissected specimens of *Fasciola hepatica* and *Cœnurus cerebralis*, but have no new facts to offer in respect of their organization or development. From a Giraffe I have obtained two forms of Cercariæ and numerous specimens of a very large fluke (*Fasciola gigantica*, mihi), details of which with coloured figures have already been published†.

*Delphinus phocæna*.—I have dissected, either in whole or in part, several individuals without detecting Entozoa; but from a specimen shot in the Firth of Forth, and kindly forwarded to me by J. Jardine Murray, Esq., in the month of April 1855, several interesting forms were obtained. The pulmonary vessels, both arteries and veins, and likewise the smaller bronchial ramifications on the left side of the thorax more especially, were extensively occupied by two species of *Strongylus*, or in other words, by the *Prosthecosacter inflexus* and *convolutus* of Diesing; two examples of the former being likewise found in the ventricles of the heart. The small intestine of this Porpoise was completely choked for the space of 8 or 9 feet by five very large tape-worms so closely impacted together that the gut presented all the appearance and firmness of a solid cylinder. Four of the worms measured severally between 7 and 10 feet in length, and the fifth about 18 inches. This worm constitutes a fresh addition to our sterelmintoid fauna. Accepting Prof. Van Beneden's classification of the cestoid Entozoa, the name now proposed will place this new genus between his diphylloid *Echinobothrium* and the pseudophylloid *Bothriocephalus*. *Diphyllobothrium stemmacephalum* (mihi) may be briefly characterized as follows:—Length upwards of 100 inches, greatest breadth  $\frac{5}{8}$ ths of an inch; head arched, supported by a narrow neck, the latter rapidly increasing in breadth; bothria two in number, compressed, shallow, subsessile, together forming a semicircular festooned crown; segments  $\frac{1}{2}$ th to  $\frac{1}{6}$ th of an inch broad from above downwards, marked by 10 or 12 longitudinal furrows, the lower border of each slightly overlapping the succeeding segment; reproductive orifices conspicuous, widely separated, both placed in the mesial line (figs. 79-83-inclusive).

\* It is highly important that the cysticercal condition of every real species of Tape-worm be indicated, otherwise the value of our breeding experiments is lost. Von Siebold (Band- und Blasenwürmer, p. 98 *et seq.*) actually denies the hitherto recognized specific distinctions of five well-marked cestodes. His view, if proved correct, would almost sanction a revival of the transmutation theory.

† Description of a new Trematode infesting the Giraffe, &c. Edin. New Phil. Journ. for 1855. See also Reports of the British Association for 1856. The fluke discovered by Professor Busk in the duodenum of a Lascar (*D. Buskii*, Lankester) exceeds in size not only the *Distoma gigas* of Nardo, but this species also in a slight degree, from which it is generically distinct.

Another still more interesting entozoon, and one which was only discovered after a very careful dissection, is a small fluke, from the gall-ducts of the liver. This minute trematode is furnished with intestinal cæca of a zigzag form, and it is of especial interest as establishing the clear-sightedness of those Entozoologists who have insisted upon a generic distinction between the organization of the common fluke (*Fasciola*) and of the Distomata properly so called; we have here, in short, an intermediate condition between the complex alimentary cæca of the one genus and the simple bifurcously divided tube of the other. For the generic and specific recognition of this species I offer the following nomenclature and characters:—*Campula oblonga*. Length  $\frac{1}{8}$ th to  $\frac{1}{4}$ th of an inch; breadth  $\frac{1}{15}$ th; oral and ventral suckers conspicuous; reproductive pores immediately in front of the latter; integument everywhere clothed with minute spines; vitelline organs largely developed; gastric cæca of a zigzag form, somewhat irregular (figs. 84, 85). This entozoon occupies the peripheral branches of the hepatic cæca, which are very much enlarged and thickened at the infested points, sometimes enclosing from fifteen to twenty individuals at one spot. In the stomach of the Porpoise there were also specimens of the crustacean *Lerneonema* and a *Filaria*, evidently belonging however to the partially digested fish-remains within that viscus.

To facilitate reference, the following is a list of the worms noticed in this paper:—

## LARVAL ENTOZOA.

- Cœnurus cerebralis*.
  - Cysticercus cucumerinus*.
  - Giraffæ.
  - fasciolaris.
  - pisiformis.
  - Scolex polymorphus*.
  - tetrahynchus.
- NEMATOIDEA.
- Filaria attenuata*, *R.*
  - piscium, *R.*
  - rubella ?, *R.*
  - Trichosomum falconum*, *R.*
  - longicolle, *R.*
  - Spiroptera leptoptera*, *R.*
  - Prosthecosacter convolutus*, *Dies.*
  - inflexus, *Dies.*
  - Oxyuris ambigua*, *R.*
  - ornata, *Duj.*
  - Ascaris acanthocaudata*, *T. S. C.*
  - acuminata, *Schrank.*
  - aucta, *R.*
  - clavata, *R.*
  - collaris, *R.*
  - depressa, *R.*
  - leptoptera, *R.*
  - marginata, *R.*
  - mystax, *R.*
  - nigrovenosa, *R.*

- Ascaris rigida*, *R.*
- spiculigera, *R.*
- vesicularis, *Fröl.*
- Dachnitis globosa*, *Duj.*
- sphaerocephala, *Duj.*
- Dochmius tubæformis*, *Duj.*

## ACANTHOCEPHALA.

- Echinorhynchus acus*, *R.*
- anthuris, *Duj.*
- tereticollis, *R.*
- Pentastoma proboscideum*, *Brem.*

## CESTOIDEA.

- Bothriocephalus coronatus*, *R.*
- punctatus, *R.*
- rugosus, *R.*
- Ligula reptans*?, *Dies.*
- Gymnorhynchus reptans*, *R.*
- Diphyllobothrium stemmacephalum*, *T. S. C.*
- Tetrabothrium cylindraceum*, *R.*
- macrocephalum, *R.*
- Schistocephalus dimorphus*?, *Crep.*
- Tænia crassicollis*, *R.*
- elliptica, *Batsch.*
- filicollis, *R.*
- serrata, *Goeze.*
- sphaerophora, *R.*
- variabilis, *R.*

## TREMATODA.

<i>Fasciola gigantica</i> , T. S. C.	<i>Distoma clavigerum</i> , R.
— <i>hepatica</i> , Linn.	— <i>cylindraceum</i> , Zed.
<i>Campula oblonga</i> , T. S. C.	— <i>fulvum</i> , R.
<i>Hemistomum spathula</i> , Dies.	— <i>gracilescens</i> , R.
<i>Echinostomum spinulosum</i> , R.	— <i>hispidum</i> , <i>Abildg.</i>
<i>Monostoma caryophyllum</i> ?, Zed.	— <i>rachion</i> , T. S. C.
— <i>dubium</i> , T. S. C.	<i>Polystoma integerrimum</i> , R.
<i>Distoma atomon</i> , R.	

The names here abbreviated are those of Rudolphi, Bremser, Dujardin, Diesing, Linneus, Zeder, Crœplin, Frölich, and Abildgaard.

## DESCRIPTION OF THE PLATES.

## TAB. XXXI.

- Fig. 1. *Tænia filicollis*. Natural size.
- Fig. 2. *Monostoma caryophyllum*, imperfectly developed. Natural size.
- Fig. 3. The same, showing an oral sucker and cells in the interior. Magnified 300 diameters.
- Fig. 4. *Monostoma dubium* (mihi). Natural size.
- Fig. 5. The same, displaying the elongated ventral appendage and internal gastric cæca. Enlarged 200 diameters.
- Fig. 6. Four examples of *Distoma fulvum*. Natural size.
- Fig. 7. One of the above, showing the position of the suckers and the extremely attenuated neck during elongation. Enlarged 20 diameters.
- Fig. 8. The same, during contraction; it also exhibits the intromittent organ and ova within the uterine tube. Magnified 60 diameters.
- Fig. 9. Three specimens of *Distoma rachion* (mihi). Natural size.
- Fig. 10. One of the above, enlarged 40 diameters. It exhibits the regularly arranged dermal spines investing the whole of the body; an oral and ventral sucker, the lining membrane of the former consisting of polygonal cells; a narrow œsophagus communicating with a broad, elongated, horse-shoe-shaped digestive cavity—in front of the latter a wide uterine tube symmetrically disposed in coils on either side and filled with ova; and an internal seminal vesicle. The ovary is placed immediately above the caudal vesicle, and is surmounted by the testes.
- Fig. 11. Transparent cyst from the subperitoneal surface of the intestine of a Haddock. Natural size.
- Fig. 12. The same, ruptured. Magnified 4 diameters.
- Fig. 13. Scolex of *Tetrarhynchus*, escaped from the cyst. It shows the head and body enveloped by the large caudal vesicle, the surface of which is slightly segmented and dotted by the highly refracting sclerous particles. Magnified 4 diameters.
- Fig. 14. The same with the body and proboscides evolved. Natural size.
- Fig. 15. Part of the Scolex, enlarged 20 diameters. It exhibits the four narrow and pointed phylloid bothria, a portion of the transparent caudal vesicle with its sclerous particles, and more particularly the four proboscides, two of which are partially withdrawn from their sheaths.
- Fig. 16. An oval sclerous particle, magnified 200 diameters.
- Fig. 17. Section of a proboscis or tentacle, showing the peculiar arrangement of the hooks and hooklets. Magnified 200 diameters.

- Fig. 18. Lower part of one of the proboscides, showing the retractor muscle within the sheath. Magnified 60 diameters.
- Fig. 19. Anastomosing tubes seen beneath the skin, at the lower part of the body, in front of the proboscideal sheaths. Magnified 260 diameters.
- Fig. 20. Two specimens of *Dachnitis globosa*; male and female. Natural size.
- Fig. 21. Anterior extremity of the same (male), showing the position of the mouth and muscular œsophagus. Magnified 260 diameters.
- Fig. 22. Tail of the same, showing the sabre-shaped spicules and a depression immediately in front. Magnified 260 diameters.
- Fig. 23. Section from near the centre of the female, showing more particularly the vaginal sheath and prominent folds of the vulva. Magnified 200 diameters.
- Fig. 24. *Ascaris acanthocaudata* (mihi). Natural size.
- Fig. 25. Section of the same, magnified 260 diameters. It exhibits the longitudinal muscular fibres with their nuclei, and a broad band of partially disintegrated cells, in the centre of which is a canal occupied by an apparently nervous thread.
- Fig. 26. Tail of the same, with numerous minute spines at the tip. Magnified 260 diameters.

## TAB. XXXII.

- Fig. 27. Anterior part of *Ascaris collaris*, exhibiting the small trilobular mouth, muscular œsophagus and broad intestine; also four cœcal appendages, two on either side of the digestive tube. Magnified 200 diameters.
- Fig. 28. Several examples of *Scolex polymorphus*. Natural size.
- Fig. 29. Head of *Scolex polymorphus*, showing the four suckers, the retracted proboscis, the so-called water-vascular canals, the sclerous particles, carmine pigment-cells, and columnar epithelium. Magnified 400 diameters.
- Fig. 30. Cyst from the peritoneal cavity of a Halibut. Natural size.
- Fig. 31. *Distoma atomon* removed from the cyst. Natural size.
- Fig. 32. The same, showing the suckers, the simple gastric cœca, uterine tube, and contractile vesicle at the inferior extremity. Magnified 20 diameters.
- Fig. 33. Four examples of *Distoma gracilescens*. Natural size.
- Fig. 34. One of the same, magnified 60 diameters. It displays the spinose tubercles of the skin, the position of the suckers, the central penis-sheath, the botryoidal vitelline organs on each side of the neck, the two (or four?) testes, the uterine tube, the ovary and seminal reservoir, and the large muscular contractile vesicle\*.
- Fig. 35. Bunch of vitelline organs. Magnified 100 diameters.
- Fig. 36. Section of the uterine tube, with its double row of contained ova. Magnified 100 diameters.
- Fig. 37. Ovum. Magnified 260 diameters.
- Fig. 38. Outline of a dissection of the Short Sun-fish, showing in particular several *Gymnorhynchi* enclosed in cysts within the retractor muscles of the anal fin. Reduced to  $\frac{1}{6}$ th of the natural size.
- Fig. 39. Head, neck, and subcervical enlargement of *Gymnorhynchus reptans* enclosed within a transparent sheath. Enlarged  $\frac{1}{3}$ rd of the natural size.
- Fig. 40. Anterior fourth of the body of *Gymnorhynchus reptans* removed from its investing capsule. Natural size.
- Fig. 41. A few articulations from the posterior part of the body. Natural size.
- Fig. 42. Club-shaped proboscis exhibiting a multitude of small hooklets serially disposed in rows of six-

\* Von Siebold, in his 'Lehrbuch der vergleich. Anat.,' speaks of three or four testes in *D. appendiculatum* and *D. cygnoides*.



teen to each circle; the hooks of the two lowermost rows being very large. Magnified 20 diameters.

Fig. 43. Diagram of one of the circlets showing the arrangement of the lesser hooks. Magnified 60 diameters.

Fig. 44. One of the large hooks, to show the blunt extremity directed diagonally outwards and downwards. Magnified 260 diameters.

Fig. 45. A small hook, showing its sharp and curved tip pointed vertically downwards. Magnified 260 diameters.

Fig. 46. Head, viewed from above, to illustrate the form and aspect of the two lateral bipartite suckers and the position of the closed orifices of the proboscideal sheaths. Enlarged 8 diameters.

Fig. 47. *Echinostomum hispidum*. Natural size.

Fig. 48. The same, enlarged 15 diameters. It exhibits the uterine tube, testes, ventral sucker and integumentary spines.

### TAB. XXXIII.

Fig. 49. Another view of the head, showing the oral sucker.

Fig. 50. Cutaneous spines. The uppermost one is from the neck; the central, from the first row surrounding the head; the lowermost, from the second cephalic circle of spines. Magnified 200 diameters.

Fig. 51. *Dachnitis sphaerocephala*. Natural size.

Fig. 52. *Distoma clavigerum*. Natural size.

Fig. 53. The same, enlarged 12 diameters.

Fig. 54. Section of the intestinal tube of the speckled Salamander, laid open to exhibit the mode of attachment of *Echinorhynchus anthuris* to the mucous surface. Natural size.

Fig. 55. One of the males, enlarged 8 diameters.

Fig. 56. Caudal extremity of a female, showing the artificially distended and transparent integument, the muscular sac enclosing the reproductive organs, the central oviduct, and certain peculiar accessory glands. Magnified 200 diameters.

Fig. 57. One of the loose globular ovaries containing ova in their nascent condition.

Fig. 58. Another ovary more advanced.

Fig. 59. A series of ova isolated from the above to exhibit their different stages of development.

Fig. 60. Fully developed ovum enclosed in a cyst.

Fig. 61. Front view of the same.

Fig. 62. Ovum detached from its enveloping cyst, showing the lateral position of the yolk and the peculiar Trichina-like form of the membrane enclosing the albumen. The last six figures are severally magnified 350 diameters.

Fig. 63. *Tænia sphaerophora*. Natural size.

Fig. 64. Head of the same. Magnified 200 diameters.

Fig. 65. Section from three of the segments showing the external reproductive organs and imperfectly developed ova. Magnified 200 diameters.

Fig. 66. Prosclex removed from one of the caudal segments.

Fig. 67. Another still more advanced, showing the inverted rostellum with its three pairs of hooks. Magnified 500 diameters.

Fig. 68. *Echinostomum spinulosum*. Natural size.

Fig. 69. The same, enlarged 10 diameters.

Fig. 70. Posterior view of the head, showing the fin-like disposition of the cephalic spines.

Fig. 71. Diagram illustrating the arrangement of the vitelline caeca.

Fig. 72. Ovum. Magnified 300 diameters.

- Fig. 73. Three examples of *Tenia serrata* of about seventy hours' growth. Natural size.
- Fig. 74. Head of one of the above. Magnified 10 diameters.
- Fig. 75. *Tenia cucumerina*. Natural size.
- Fig. 76. Head of the same, enlarged 25 diameters.
- Fig. 77. Joints of the same, showing the male reproductive organs opening at both of the lateral margins, also the ova and water-vascular canals. Magnified 25 diameters.
- Fig. 78. Male organs, consisting of testes and vas deferens, and the penis retracted within its sheath. Magnified 60 diameters.
- Fig. 79. Head and anterior segments of *Diphyllobothrium stemmacephalum*. Natural size.
- Fig. 80. Section from near the centre of the body. Natural size.
- Fig. 81. Head and neck, enlarged 100 diameters.
- Fig. 82. Lateral or marginal view of the same.
- Fig. 83. Appearance of the bothria when viewed from above.
- Fig. 84. *Campula oblonga*. Natural size.
- Fig. 85. The same enlarged 20 diameters, exhibiting more particularly the peculiar zigzag conformation of the digestive cæca.